REMARKS

The foregoing corrections to the specification and drawing are submitted to correct typographical errors, and it is respectfully submitted that no new matter has been added. The Examiner is invited to contact the undersigned for any questions.

Respectfully Submitted;
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the system 400 (Figure 4), unless indicated otherwise. Such operations are sometimes referred to as being computer-executed. It will be appreciated that operations that are symbolically represented include the manipulation by a processor of electrical signals representing data bits and the maintenance of data bits at memory locations in system memory (not shown), as well as other processing of signals. The memory locations where data bits are maintained are physical locations that have particular electrical, magnetic, optical, or organic properties corresponding to the data bits.

When implemented in software, the elements of the present invention are essentially the code segments to perform the necessary tasks. The program or code segments can be stored in a processor readable medium or transmitted by a data signal embodied in a carrier wave over a transmission medium or communication link. The "processor readable medium" may include any medium that can store or transfer information. Examples of the processor readable medium include an electronic circuit, a semiconductor memory device, a ROM, a flash memory, an erasable ROM (EROM), a floppy diskette, a CD-ROM, an optical disk, a hard disk, a fiber optic medium, a radio frequency (RF) link, etc. The computer data signal may include any signal that can propagate over a transmission medium such as electronic network channels, optical fibers, air, electromagnetic, RF links, etc. The code segments may be downloaded via computer networks such as the Internet, intranet, etc.

Returning to Figure 2, the speech signal 210 is routed to a rate determination controller module 220 for analyzing the speech signal on frame-by-frame basis. Each frame of speech is analyzed by the rate determination controller 220 in order to select one of the speech encoders 230-250, for the most efficient use of the communication channel 260. As understood by those of ordinary skill in the art, for example, frames of speech are sampled at 10 ms intervals or blocks under the G.729 standard. An

analysis of each 10 ms frame of speech, using well-known methods, the rate determination controller 220 may select one of the plurality of speech encoders 230, 240 and 250.

For example, if the speech signal has the shape or characteristics of a male voice, the rate determination controller 220 may position the encoder selector 212 to select a medium data rate speech encoder, such as the speech encoder 230, G.729 6.4 kbps, to encode that particular frame. For the next frame, however, if the rate determination controller 220 finds a higher quality speech frame, such as music-like speech, the rate determination controller 220 may position the encoder selector 212 to select a high data rate encoder, such as the speech encoder 250, G.729 11.2 kbps, to encode that speech frame in order to prevent quality degradation. In one embodiment, the speech encoder 250 of the system 200 may be a G.727 ADPCM 24.0 kbps, in that event, positioning the encoder selector 212 to the speech encoder 250 by the rate determination controller 220 would cause the speech frame be encoded using the G.727 standard..

It should be noted that according to one embodiment of the present invention, various numbers of speech encoders of different standards may be included in the speech encoding system 200. Such embodiment, of course, requires a complementary speech decoding system that can support these various speech encoders in order to decode the speech on a frame-by-frame basis.

However, in some embodiments, the speech encoding system 200 may encode the speech frames using various speech encoders belonging to a single standard, such as G.729 Annex I. Such systems are advantageous since they require no change to the conventional decoding systems.

The rate determination controller 220 may be implemented as hardware, firmware or software, or any combination thereof. The resulting bit stream from each of the speech encoder 230, 240 and 250 is provided to a communication channel 260.

As described above, speech signal 210 is first routed to the rate determination controller 220 on a frame-by-frame basis. Once the speech signal 210 is routed to the rate determination controller 220, a predetermined flag in the header of the speech frame is analyzed to determine classification of the speech frame. For example, the value of the flag in the speech frame may indicate that the speech frame is a non-active speech signal (background noise or silence) and thus is to be processed by a low bit rate encoder. The value of the flag in the speech frame may indicate that the speech frame is an active speech and of high quality, such as music, and is thus to be processed using a high bit rate encoder. In the alternative, The value of the flag in the speech frame may indicate that the speech frame is an active speech but of medium quality, such as male voice, and is thus to be processed using a medium bit rate encoder. Once the encoding scheme is determined, the speech frame is routed to one of the speech encoders 1..n via the encoder selector 212. It is understood that classification of the input speech may be accomplished by any type of control circuit or software, based on a predetermined standard, criterion or set of criteria, or based on system requirements and/or need.

Turning to Figure 3, a speech signal diagram 300 is shown. Figure 3 illustrates a speech signal 330 mapped into amplitude 310 / time 320 axis. The speech signal 330 is broken down into blocks of time as denoted by vertical dotted lines. Each block of time a-v, on the time line 340, represents one frame of speech. As stated above, one frame of speech is, for example, 10 ms in duration per G.729 ITU standard, or in some embodiments, frames are in 5 ms intervals. Referring back to

Figure 2 and assuming the speech encoders 230, 240 and 250 are G.729 1.5 kbps, G.729 8.0 kbps and G.726 32.0 kbps, respectively, when the speech frame (a) of speech signal 330 enters the encoding system of 200, the rate determination controller 220 first determines the type speech in speech frame (a) based on well-known methods known to those of ordinary skill in the art. As shown, speech frame (a) is low quality speech or background noise and thus the rate determination controller 220 may position the encoder selector 212 to select a low data rate speech encoder, such as the speech encoder 230 at 1.5 kbps, to encode speech frame (a). As for the next speech frame (b), the rate determination controller 220 may retain the same position for the encoder selector 212. However, for the speech frames (c) and (f), the rate determination controller 220 may select a medium data rate, such as the speech encoder 240 at 8.0 kbps. As for speech frames (h), (i), (l) and (m), the rate determination controller 220 may select a high data rate speech encoder, such as the speech encoder 250 at 32.0 kbps, to preserve the quality of speech.

Figure 4 illustrates another embodiment of the present invention. As shown, the speech encoding system 400 includes a network controller 430, a rate determination controller 420 and a plurality of speech encoders 1..n, denoted 440, 450, 460, 470 and 480, respectively, for transmitting speech signal 410 over a communication channel 490. According to this embodiment, the network controller 430 may select one of a plurality of groups of speech encoders for encoding the speech signal 410. The network controller 430 may route the speech signal 410 either through line 412 or 414 according to predetermined factors of the network provider. As shown, line 412 routes the speech signal 410 to a first group of encoders, including speech encoders 440, 460 and 480. Line 414, on the other hand, routes the speech signal 410 to a second group of speech encoders, including speech encoders, 440, 450, 460, 470 and 480. In one embodiment, the speech encoders 440, 450, 460, 470 and

480 may support different data rates of G.729 Annex I, 0, 1.5, 6.0, 8.0 and 11.2 kbps, respectively. In another embodiment, the speech encoder 440 may support 0 kbps data rate of the G.729 Annex I standard, the speech encoder 450 may support 5.3 kbps of the G.723.1 standard, the speech encoder 460 may support 8.0 kbps data rate of the G.729 Annex I standard, the speech encoder 470 may support 16.0 kbps data rate of the G.728 standard and the speech encoder 480 may support 64.0 kbps data rate of the G.711 standard. In short, various data rates of different standards may be combined and supported accordingly.

Just as explained above in relation to the embodiment of Figure 2, the rate determination controller 420 may route each frame of the speech signal 410 using encoder selectors 413 and 415 to one of plurality of the speech encoders according to characteristics of each speech frame. However, the network controller 430 may designate a specific group of speech encoders that may be utilized by the rate determination controller 420. For example, during certain hours of the day, the network controller 430 may route the speech signal through the line 412 to the encoder selector 413 which provides less number of speech encoders to choose from for use by the rate determination controller 420.

The present invention thus provides an apparatus and method for providing flexible variable bit rate encoding. The flexible encoding scheme facilitates encoding of speech using any desired standard, criteria or fixed rate-bit encoders. In one embodiment, the speech encoders 440-480 may be existing fixed bit-rate encoders, such as GSM EFR (enhanced Full-Rate), IS-641 (TIA/EIA TDMA standard), etc., or in yet other embodiments, the speech encoders 440-480 may include single multi-rate standards, such as GSM AMR (adaptive multi-rate), or any combinations of the above.